

## MODULE 4

# AN INTRODUCTION TO SOLID WASTE MANAGEMENT





# AN INTRODUCTION TO SOLID WASTE MANAGEMENT

## OBJECTIVES:

- ✚ To define and identify different types of solid waste.
- ✚ To analyse solid waste management strategies.
- ✚ To explore issues surrounding solid waste management in the region.

## OVERVIEW:

- ✚ The types and sources of solid waste vary widely from domestic to industrial, from construction to tourism and agriculture.
- ✚ Main problems in the region stem from lack of planning, weak infrastructure and weak public awareness.
- ✚ Focus must change from managing the end product only. Solid waste management includes prevention, reuse, recycling and disposal.





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### INTRODUCTION

The generation of waste is an inevitable part of human activity. It is produced either as a by-product of production processes, or arises from the domestic or commercial sector when objects or materials are discarded after use.

The natural environment is the recipient of human waste materials. Many of these are completely different to natural materials. It would appear that most environmental problems arise because the natural world cannot cope with these substances. We therefore need to manage the quantities of waste produced, and how it is disposed of.

### WHAT IS SOLID WASTE?

Solid waste can be defined as: the useless and unwanted products in the solid state, derived from the activities of and discarded by society.



The average person usually thinks of solid waste in one of the following terms:

**Garbage:** the term given principally to food waste, but may include other putrescible or degradable organic wastes.

**Rubbish:** consists of combustible and non-combustible solid waste, excluding food wastes.

**Refuse:** the collective term for solid wastes, includes both garbage and rubbish.

**Litter:** odds and ends, bits of paper, discarded wrappings, bottles etc. Left lying around in public places.



### Municipal Waste

Solid waste generated by public, domestic and collecting activities, including waste effluent to the treatment plants.

### Municipal Sources

- a) residential areas
- b) commercial areas
- c) public areas and streets
- d) treatment plants

### Industrial Waste

Waste generated by industrial activities, including domestic garbage, ash construction waste material, especially industrial waste and hazardous waste.

### Hazardous Waste

These types of waste represent a potential danger, immediate or not, to human life, wildlife and plants. Solid waste is categorised as dangerous if it has the following characteristics:

- a) inflammable
- b) corrosive
- c) reactive
- d) toxic



The actual sources of solid waste vary widely:

- a. **Domestic or Municipal** - from homes and offices come a complete range of materials such as paper, plastics, organic, hazardous (insecticides, cleaning products).
- b. **Industry/Manufacturing** - the "non-value" waste materials from processes.

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c. **Agriculture** - vegetation from clearing land, empty containers from pesticides, fertilizers.

d. **Construction** - debris, concrete, metal, paint, tiles, etc.



e. **Hospital/ medical**  
- medical wastes, used needles, spent and outdated drugs.

f. **Tourism** - mainly domestic solid wastes from hotels, cruise ships, yachts, restaurants etc.

g. **Hazardous** - materials which exhibit ignitable, corrosive, reactive, or toxic characteristics.

## ISSUES SURROUNDING SOLID WASTE MANAGEMENT IN THE REGION

In the Caribbean the problem of solid waste management has grown increasingly complex in tandem with the advancing processes of urbanization and industrialization

In general, the management of solid waste has not achieved a satisfactory standard within the Wider Caribbean region. This is due to the inadequate collection of data on solid waste issues and public health concerns. Cities and populations have been growing, solid waste management, however, has not kept pace with this growth, resulting in decreased efficiency of public services.

### Principal problems are:

- ↗ lack of planning and programmes
- ↗ insufficiency of qualified personnel

- ↗ physical resources insufficiently utilized
- ↗ incomplete legislations
- ↗ institutional or structural weakness
- ↗ limited community participation

The underlying causes of inadequate control and management of solid waste are outlined below.

- ↗ weakness of municipal administration
- ↗ lack of technical support
- ↗ insufficient guidelines and regulations to control and manage solid waste

The consequences of inadequate control and management of solid waste are outlined below.

- ↗ weakness of municipal administration
- ↗ lack of technical support
- ↗ insufficient guidelines and regulations to control and manage solid waste

Within the tourism sector solid waste is mainly municipal or domestic, the following discussion will address these two groups.

In the Caribbean the problem of solid waste management has grown increasingly complex in tandem with the advancing processes of urbanization and industrialization. Solid waste management should take into account on the one hand, public health considerations that require prompt and efficient collection and a final disposal that avoids irreversible impact to the environment and human health. At the same time the conservation of natural resources must also be considered, leading to the establishment of policies that promote source reduction and recycling. Thus it is no longer enough to only understand the technical and financial aspects of operations such as waste collection and final disposal. Also necessary are a broad array of social instruments, including

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environmental, ecological, and public health education and above all, methods and mechanisms for achieving community participation.

### SOLID WASTE GENERATION

The solid waste generation originates from determined sources at determined times.

Aspects which influence the solid waste generation are:

- ↗ geographic location
- ↗ season of the year
- ↗ collection frequency
- ↗ population characteristics
- ↗ scope of recovery and recycling operations
- ↗ legislation
- ↗ public activities

Methods have been developed to measure the volume, weight and characteristics of solid waste to determine the total amount of solid waste handled and develop appropriate management systems. Data reporting on solid waste generation obtained from different reports, often use different methods of waste

classification. The following methods can be used to determine the solid waste value per resident:

#### Load Count

In the analysis of load count, the number of individual load and vehicles characteristics are noted down at the period of time specified. If they are on scale, the empty and full vehicles could be weighed to know the real waste weight that the truck is transporting; if not, it is necessary to know the truck volume and the garbage density of the vehicle.

#### Volume Weight

The analysis of volume - weight, weighing and measuring each load is possible to obtain information about solid waste density.

#### Material Balance

The analysis of material balance is a very expensive method and difficult to apply, and therefore, not used generally.

Tables 1, 2 and 3 provide data on waste generation characteristics for European and Latin American countries.

**Module 4 - Table 1**  
Waste Generation: Area, Region or Country

Area or Country	Generation value
	Kg/resident/day
Western Europe	1.1
United States	1.6-2.2
Latin America	0.4-1.0
Mexico	0.32
Typical cities in Asia and North Africa	0.72
Low income areas south west of Asia	0.4
Typical cities in industrialised nations	1.1
Typical cities (high income, USA)	2.5

**Module 4 - Table 2**  
Composition of Solid Waste for Some Countries

Compound	England	India	Mexico	Ecuador
biodegradable vegetal (%)	28	75.2	55	66.5
paper (%)	32	1.5	15	17.9
metal (%)	9	0.1	6	1.4
glass (%)	9	0.2	4	1.7
textile (%)	3	3.1	6	3.1
plastic (%)	3	0.9	4	2.7
combustible (%)	1	0.2	2	3.0
non combustible (%)	1	6.9	6	0.9
Inert<10mm (%)	9	12	0	3.8(30mm)

## GENERATION AND CHARACTERISTICS

### Physical Characteristics

The physical composition of solid waste is determined primarily by four methods:

1. Identify the individual components.
2. Analyse the size of the particle.
3. Determine the moisture content.
4. Determine the density.

**The individual components** of solid waste depend fundamentally on the source and generation. In general, domestic solid waste contains:

- ↳ paper
- ↳ cartons
- ↳ food containers
- ↳ glass

- ↳ cans
- ↳ plastic
- ↳ food remains
- ↳ garden waste
- ↳ others (refrigerators, furniture)

The garbage generated at public centers depends on the type of commercial activities. For example, the garbage from hotels and restaurants, have a high food content; garbage from offices contains paper, etc.

The selection of the components is dependent on the source. Therefore, the component distribution is a critical factor in the particular process of establishing appropriate solid waste management.

**The size of material (particle size) component** of solid waste is also critical for the recuperation of materials, especially through a mechanical system such as screener and magnetic separators.



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The **moisture content** of solid waste is usually between 15 - 40%, depending on its composition, the season and humidity. The moisture content is expressed as weight of humid air per unit of dry - or net material.

$$\text{Humidity/} \\ \text{Moisture Content} \quad (\%) \quad = \quad \frac{a-b \times 100}{M \text{ (d or w)}}$$

Where: a = initial weigh; b = weight after drier  
M (d or w): weight of material wet or dry before dried

The moisture content can be expressed in % of dry weight of material or % of net weight of material. Table 3 presents some typical moisture concentrations.

The **density** of solid waste varies considerably with the geographical situation, season and time of storage. It is important to be careful when determining typical density value. The

density value is important to evaluate the total mass and volume of water to handling.

**Module 4 - Table 3**

Typical moisture content of select components

Component	% Moisture	
	Range	Typical
food waste	50-80	70
paper	4-10	6
cardboard	4-8	5
plastic	1-4	2
textile	6-15	10
rubber	1-4	2
skin or hide	8-12	10
garden waste	30-80	60
wood	15-40	20
glass	1-4	2
tin-plate	2-4	3
non ferric	2-4	2
soil, ash, ceramic	6-12	8
municipal solid waste	15-40	20

Table 5 below reports typical density for some waste from the original sources.

**Module 4 - Table 4**

Typical density for municipal solid waste per source.

Sources	Density lb/yd <sup>3</sup>	
	Rate	Typical
residential garden waste (without compaction)	150-300	220
ash	100-250	175
residential (compacted)	1100-1400	1250
landfill (normally compacted)	300-750	500
landfill (well compacted)	600-850	750
residential after being processed	1000-1250	1000
packing	1000-1800	1200
crumble (without compaction)	200-450	360
crumble (compacted)	1000-1800	1300
commercial - industrial (without compaction)	800-1600	900
garbage, non-combustible	300-600	500
garbage, combustible	80-300	200

**Note:** 1 lb/yd<sup>2</sup>\*0.5933 = kg/m

## SOLID WASTE MANAGEMENT HIERARCHY

But how do we manage our solid waste in an environmentally sound manner? First analyses should be done to determine the different types

### Waste Hierarchy

WASTE PREVENTION  
REUSE  
RECYCLING  
/COMPOSTING  
ENERGY RECOVERY  
DISPOSAL

and quantities of waste being produced. This is known as a waste characterisation or composition exercise. The composition of the solid waste is one of the factors to be considered in selecting an appropriate disposal method. Then a decision is made on the most viable treatment or disposal option. This usually involves a play off between economics and the environment.

Options for treatment and disposal include :

1. **Landfilling** - the disposal of solid waste in layers into a lined area of land and covering of the waste with layers of earth.
2. **Incineration** - burning of waste in a properly designed furnace.
4. **Resource recovery** - collecting, reprocessing, marketing of materials e.g. aluminium, glass, paper.
5. **Material reuse** - re-utilisation of an object for the same (primary reuse) or another (secondary reuse) purpose.

## ISSUES SURROUNDING SOLID WASTE MANAGEMENT IN THE REGION

Traditionally solid waste management has been the purview of government agencies, which have had sole responsibility for this function, with little or no input from the private sector and the general public. From this approach several key issues have arisen and these must be addressed in order to move forward.



Government has many demands on its resources, therefore solid waste management professionals may sometimes have to "compete" with other sectors to receive the necessary attention.

There is an inadequacy of support systems, i.e. policy, regulation, and implementation to effectively address the problems. Thankfully this is changing. We can cite the World Bank/ Organization of Eastern Caribbean States Solid Waste Management Project as a good example. As a subset of the second issue, there are budgetary constraints leading to improper waste management because of the inability to acquire appropriate equipment.

Solid waste management has always received little respect from the general public. It is generally viewed as dirty work, and something to be best kept away from, and hidden away. This is as a result of a lack of understanding of the relationship of proper and adequate solid waste management to good public health. The need for proper monitoring and regulation, in addition to proper training of solid waste management personnel is necessary.

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Currently widespread recycling is not an economically feasible option, due to the high cost of shipping material to recycling facilities. It is commercially driven, and no Government policies regarding this option exist.

### HOW CAN WE IMPROVE OUR WASTE MANAGEMENT METHODS?

As mentioned earlier, the focus must change from managing only the end product. It is now incumbent upon all to manage how we generate solid waste.

The phrase "Reduce, Reuse, Recycle" is a common one these days. In the Caribbean the first two are most appropriate at the moment, and in some ways are already practiced. But why should we practice these activities? Siting a landfill is a difficult process, especially in our small islands of the Caribbean. The amount of land space required is large, and as it is known, no one likes the idea of having a landfill close to where they live and work, even if it is a well operated and maintained one. If the amount of waste being sent to the landfill is reduced it means the landfill will last that much longer.





## MODULE 5

# MANAGEMENT AND DISPOSAL OPTIONS FOR SOLID WASTE







# MANAGEMENT AND DISPOSAL OPTIONS FOR SOLID WASTE

## OBJECTIVES:

- To introduce a number of simple options for solid waste management.
- To introduce a number of factors and processes to consider when treating and disposing of solid waste.

## OVERVIEW:

- Clean-up campaigns may prove effective if well planned and coordinated.
- The disposal, the process and the treatment are all important factors to consider when managing solid waste.



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## MANAGEMENT AND DISPOSAL OPTIONS FOR SOLID WASTE

### INTRODUCTION

The absence of adequate infrastructure to collect and dispose of solid waste has led to the practice of indiscriminate dumping. In these conditions garbage is often found in gullies, mangroves, trenches, natural depressions, open lots and water-ways. The result is a negative impact on aesthetics, human health and the environment.

Organizations charged with the responsibility of solid waste management are often ill-equipped to effectively manage the situation because of an absence of equipment, know-how and funding. One of the activities which can be used to help to alleviate the problem is a 'clean-up' day. However, it must not be regarded as the sustainable solid waste management solution. Clean up day can set the tone for a more comprehensive solid waste management programme.

### SOLID WASTE TREATMENT

#### Clean Up Day

Clean up activities are some of the more important steps taken in preserving the health of the country, maintaining aesthetics and establishing harmony between humanity and nature.

The Clean Up activities Working Day tries to resolve the problem at two levels.

- ↳ Home.
- ↳ Public areas.

Clean up activities require finding and material resources such as trucks, excavators, and promotional materials. Nevertheless, the most important component is the availability of human resources. Community participation at every level of the society is critical to the success of clean up activities. Since everyone

in the society produces waste it is a collective responsibility to work for appropriate solutions to manage the solid waste we generate. What is also critical to the success of clean up campaigns is effective coordination of all the resources, particularly the participants.

#### Why is it Necessary to Coordinate the Clean Up Workday ?

- Improve and to make optimal use of all the resources.
- Organize educational activities to inform about health risks.

The following activities are important for each type of clean up campaign.

#### Health Centre and Hospital

- ↳ Trimming and cleaning of internal and external environs.
- ↳ Cleaning and washing of more important areas of the hospital: kitchen, storage rooms, toilets, etc.
- ↳ Installing adequate bins to collect waste and strengthening awareness in the workers.

#### School

- ↳ Trimming vegetation and cleanliness of play area.
- ↳ Cleaning of general infrastructure, washing of walls and windows, etc.
- ↳ Examining and modifying drainage to avoid stagnation.

#### Market

- ↳ Collecting solid waste and routinely washing roads and side walks at the market.
- ↳ Trimming vegetation and cleaning of surrounding area.

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- ✚ Promoting the use of bags or containers.
- ✚ Daily cleaning and washing of public sanitary facilities at the market.
- ✚ Eliminating ditches and pot holes on the road at surrounding market area.
- ✚ Inspecting sewers and drainage on the road next to the market zone.
- ✚ Controlling/ monitoring of public disposal sites at the markets with the purpose of achieving efficient collection and preventing environmental problems.

## Slaughterhouses

- ✚ Cleaning and washing of all markets, infrastructure, walls, floors, windows, slaughter area and equipment.
- ✚ Painting walls, doors, windows, of the facility to maintain the levels of sanitation and aesthetics.
- ✚ General washing of equipment at slaughterhouse.
- ✚ Adequately containing all waste for transporting to the final disposal site.
- ✚ Training personnel in sanitation methods, especially in the disposal area.

## Neighborhood and Hotels

- ✚ Trimming of vegetation and cleanliness of watershed.
- ✚ Eliminating ditches and drains.
- ✚ Cleaning and concreting ditches and drains.
- ✚ Cleaning and monitoring of sewers.
- ✚ Eliminating illegal dumping.

- ✚ Removing litter from the roads.
- ✚ Cleanliness and sanitation of houses, working place, schools, etc.
- ✚ Eliminating or reusing old tyres.

In support of activities which are necessary to guarantee that the final disposal of solid wastes is carried out at legal or institutional dumps or landfill, routine collection of garbage should be established by:

- ✚ Collecting according to:
  - neighborhood or community
  - legalisation of the illegal dumps.
- ✚ Providing an adequate number of disposal containers.
- ✚ Advising about site disposal to all workers.
- ✚ Covering the waste carried on the trucks, to avoid spillage.
- ✚ Following up with owners of unoccupied land and periodically cleaning the lots to avoid illegal dumping.

## SOLID WASTE TREATMENT DISPOSAL CONCEPT

The final disposal of the solid waste is usually on land, seldom at sea, (except ships) and in some cases, incineration of the solid waste.

## Factors to Consider in Treating and Disposing of Solid Waste:

- a) Disposal: Final operational state for cleanliness.
- b) Process: Manipulation of waste, after disposal.



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## MANAGEMENT AND DISPOSAL OPTIONS FOR SOLID WASTE

- c) Treatment: Process to achieve sanitary results by reduction of hazardous effects to human and environment.

### Processes as applicable to waste

#### 1. Machine processing of waste.

- a) Crushing: divide, mix and homogenize the waste to assist in:
- Biochemical decomposition
  - Stabilization and condensation of landfill site
  - Control the uniformity of thermal reactions.
- b) Compaction: Reduction of spaces, that is compression of waste at low cost.
- c) Classification/Recovery: Separation of materials that could be recycled.

When considering the recovery and recycling of waste to be used as raw material, it is better to repair, reform or reconvert it, that is, to reuse it in its original form such as for example; containers, bottles, etc. The recycling of bottles is an option which can reduce the volume of domestic waste, reduce treatment costs and avoid environmental impacts of treatment of waste accumulation.

Recycling is a basic treatment technique for the majority of solid waste, that improves energy savings and the conservation of natural resources. The more important items to recycle are as follows:

Organic material	Metal
Clothes	Glass
Batteries	Plastics
Medicine	Cardboard
Furniture	Paper

Successful recovery of these materials is best done by separation at the source. Therefore, provision of centralized storage facilities and collection arrangements are critical to its success. Also essential is educating the population on the purpose and benefits of the recycling programmes.

#### 2. Thermal Processes

- a) Incineration: Reduces local waste to 10% of the original weight.
- b) Pyrolysis: Thermal decomposition in the absence of oxygen occurring at temperatures below that of incineration.

#### 3. Biological Process

- a) Aerobic: Fast decomposition with final product, very stabilised,  $\text{CO}_2$ ,  $\text{H}_2\text{O}$  and organic material ( $\text{NO}_2$ ,  $\text{PO}_2$ , etc).
- b) Anaerobic: Slow decomposition, intermediate organic compounds.
- c) Composting: Biological process, the organic waste is converted into humus.

#### 4. Landfill

Landfilling - a technique of disposing of waste into a lined area in the ground without harming the environment, or causing a nuisance to health and public security. This method uses engineering principles to place the waste in a small area, reducing volume and covering with soil usually on a daily basis. However, the unavailability of cover material may result in less frequent covering.

#### Types of Landfill

##### Sanitary Landfill

- a) Mechanical
- b) Normal

**Converted Landfill**

- a) Mechanical
- b) Normal

Site Selection and Assessment

These issues should be considered during site selection and assessment:

- All conditions
- Ecology on the site - Flora and Fauna
- Geology/Topography
- Hydrology
- Soil
- Climate
- Other

Project Implementation for a Landfill

These activities should be reviewed during project implementation:

- Site identification
- Soil, water and microclimate
- Design gas recovery system
- Drainage system
- Leachate treatment

Other Activities

- Operational Plan
- Investments and Costs
- Implementation Plan

Operation of the Sanitary LandfillManagement Issues

- Control of the sanitary landfill
- Operational control
- Control of landfill construction
- Control of costs
- Control of environment

**THE WAY FORWARD**

- ➡ Move our focus from dealing with waste only after it has been generated.
- ➡ Prevent, reduce, reuse, recycle, recover, pre-cycle.